Section Life Cycle Management

Working Groups

International Expert Group on Life Cycle Assessment for Integrated Waste Management
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1 Roundtable Updates – Developments, Studies and Tools

1.1 Update from the UK

Terry Coleman of the UK Environment Agency presented an update on the Agency's LCA tool for waste management. A contract has been let for the development of a new LCA tool for IWM that will be made publicly available. Foreground waste management data are now being collected. The Environment Agency also has two LCA studies near completion; one on treatment options for waste car tyres and another study investigating the environmental burdens associated with reusable and disposable nappies. Both will be published next year.

Forbes McDougall of Procter & Gamble described a recent conference held in the UK titled 'Zero waste – myth or reality'. There is a real concern that the public will be mislead by the Zero Waste claim as it promises to solve waste management problems and deliver very high recycling rates without addressing the concurrent environmental burdens and the inevitable waste from recycling and treatment processes. Most of the municipalities in Europe and Australasia that have adopted the zero waste concept have ignored LCA in developing their strategy options for solid waste management. An exception to this is the Porto municipality in Portugal that is using LCA concepts in waste management technology appraisal.

1.2 Update from USA

Susan Thorneloe of the US Environmental Protection Agency (EPA) provided an update on the U.S. Decision Support Tool for Municipal Solid Waste (MSW-DST). Funding has been secured through a partnership between the EPA and the Research Triangle Institute, to develop web-accessible version of the tool. This will go through stakeholder, US-EPA and quality assurance review. The final version is expected for release in spring 2005. The LCI database for North America is currently being updated. The stand-alone database contains LCI energy data for national and regional grids, LCI data for material production, and LCI data for MSW unit processes. The database will also provide MSW-DST results for different sized communities using default data based on typical U.S. operations. The final version of the database is to be released through RTI in the next few months. RTI is working with the California Integrated Waste Management Board to evaluate conversion technologies (acid hydrolysis, catalytic cracking, and gasification) being considered as alternatives to land disposal for materials that are not recovered through recycling or composting. The tool will help establish a benchmark to ensure that material and energy balances are calculated throughout the life-cycle on a component basis.

1.3 Update from Germany

Jürgen Giegrich of the IFEU Institute, Heidelberg highlighted renewed political interest in waste management in Germany in the following areas. 1) A draft regulation for the German one-way packaging deposit that is considering the use of LCA by government and industry to classify beverage packaging into environmentally favourable and unfavourable systems. 2) The costs and benefits of the alternative collection systems are being assessed with LCA. 3) Landspreading of sewage sludge will be phased out in a number of federal states. LCA studies are being updated on the balance between soil organic benefits versus incineration. 4) The ban on untreated waste to landfills by 2005 is requiring alternatives to landfill to be developed rapidly. 5) There is interest in reprocessing existing landfills, in particular re-engineering the landfills with potential impact on ground water. 6) A review of German Waste Management Policy for the past decade has been started.

1.4 Update from Sweden

Göran Finnveden of FMS, Sweden reported that an incineration tax is under consideration in Sweden. LCA is being used to assess the effect of various economic and waste management system alternatives. Other work in Sweden has started carrying out environmental analysis for Strategic Environmental Assessment in Waste Management plans, with case studies. Goran is also involved in writing a book on waste management and a specific chapter on LCA for waste management is included. Swedish LCA-studies have been used in judicial discussions about an Austrian Landfill tax.

1.5 Update from European Commission, DG Joint Research Centre (JRC)

David Pennington outlined the work of the JRC Soil and Waste Unit in Ispra, Italy. The JRC provides independent scientific support to the various Commission Directorates, to the EU member states, and to the EU community. Topics of general interest include LCA in the context of supporting the EC Waste Prevention and Recycling Strategy, The Sustainable Use of Natural Resources Strategy, the related Integrated Product Policy communication, the Strategic Environmental Assessment Directive, as well as the challenges and opportunities faced by accession of new countries to the EU. Current activities include a life cycle inventory database and harmonised data format which are under development. A harmonised European impact assessment methodology capable of supporting community activities and policy is under consideration, and associated waste management case studies are underway through various collaborations.

1.6 Other updates

Simon Aumônier of ERM described his work using LCA to support Municipal Authorities in developing their waste management plans and strategies and countering/supporting plan-

ning applications for waste management facilities. ERM have also started a number of new waste-related LCA studies including paper sludge and incineration of animal residues.

Susana Xara of the Catholic University of Porto, Portugal described her work on LCA including a comparative evaluation of the environmental impact of incineration, landfill and recycling alkaline batteries, including work on batteries characterisation. The processes of landfilling and incineration of batteries were simulated in a laboratory to quantify mainly heavy metals emissions. Work has been done with the co-operation of Portuguese industry evaluating of the impact of glass and plastic bottles used for mineral water. A tool for the evaluation of integrated municipal solid waste management options for the Portuguese situation is being developed. Current activities include development of the landfill model and the development of the LCA inventory for the electricity production and use in Portugal.

Umberto Arena of the University of Naples, Italy provided an overview of Italian LCA work. The use of LCA in regional waste management policy development is suffering from a reduction in resources of the Italian Environment Agency. The emphasis is now turning to Environmental Impact Assessment not LCA. The LCA work that is ongoing includes LCA studies on plastic containers, paper and packaging waste including the supply chain and work in 3 universities (Naples, Torino, Bologna) is focussing on simplifying LCA results for decision-makers.

David Hall of Golder Associates described their work assisting the UK Environment Agency in developing a source term model for monolithic waste. Similar projects are running in several EU Member States and collaboration with the Swedish, Finish, Danish and Dutch programmes is ongoing.

Niels Dengsøe of the National Environmental Research Institute, Denmark outlined his work on LCA, Cost Benefit Analysis (CBA) and externalities valuation.

Sarah Cowell of the University of Surrey (UniS), UK outlined a number of projects and her work at UniS where she directs a programme on Environmental Life Cycle Management. The proximity principle is being tested using LCA for waste management with a number of case studies. UniS are also developing an approach for evaluating negative global warming potential, and have undertaken an LCA study on the effectiveness of the WEEE Directive.

Tomas Ekvall described a number of market studies investigating a) consequences of Swedish waste incineration on the production and use of biofuel b) consequences of Swedish paper recycling on the marginal pulpwood production c) trade of waste fuel into Sweden d) application and assessment of consequential and attributional LCA methodology.

Stefan Salhofer of Boku University, Austria is involved in a Austrian case study on Strategic Environment Assessment for waste management which includes LCA as one element in community stakeholder decision-making as one element

2 New Research

2.1 Environmental performance of waste management options for residual waste

Umberto Arena of the University of Naples, Italy presented an LCA study on alternatives for residual municipal solid waste management. The Campagnia region of southern Italy has used LCA to model waste management alternatives that include Materials Recovery Facilities and Recycling facilities, but also uses LCA to evaluate and improve alternatives for residual waste treatment (i.e. after recyclables have been removed). The study examined the end use treatment of residual waste materials that are either a) landfilled as usual b) mass burnt in an incinerator c) undergo a typical RDF-Mechanical Biological treatment where post sorted residues are incinerated, landfilled and utilised. All the scenarios were found to have a positive benefit due to energy displacement against the average Italian energy production mix, which is mainly gas and oil. The mass burn incineration option was favoured in energy terms but the RDF scenario was preferred for materials recovery. Engineers used the process models that were constructed to vary process design and operating criteria and made recommendations that were accepted in the contracts for the design of the new facilities. See 'Journal of Chemical Engineering' 96 (1–3) 207–222 (xxx).

2.2 Industrial ecology and input-output analysis

Paulo Ferraro of the Technical University of Lisbon, Portugal provided an overview of his work. In Portugal the Direct Materials Input (indicator of the resource productivity of the Economy) is increasing with GDP and he is investigating the decoupling of this relationship using Materials Flow Analysis and LCA. The approach uses input-output models limited to LCA for each sector and for products of the Portuguese economy using the analysis of a 'Hybrid Economic Input-output-LCA' matrix. This is being used to forecast future waste production (or consumption) as the economy grows and technology changes. Paulo's group is also undertaking a number of LCAs on types of food packaging in their end-of-life phase for the Green Dot scheme and a waste input-output model has been used to assess the scope for industrial ecology in ELV and WEEE sectors.

2.3 LCA for waste management and Cost Benefit Analysis

Niels Dengsøe described his work for the Danish National Environmental Research Institute. He is working on CBA for Waste Management using LCA methodology as promoted by the ExternE methodology and the OECD stated proposal to link LCA with CBA. Discussion focused on the concern that the monetisation of the impacts of waste management into a single value would hide the value judgements of some 5–6 factors common to waste management decision-making. Niels suggested that CBA could complement impacts information in a decision-making context and highlighted time-discounting as a major issue in view of uncertainty in LCA and CBA due to both disciplines requiring forward evaluation. Simon Aumônier commented that a single financial figure can provide spurious sense of certainty, but emphasised that this is a problem of the underdevelopment of the procedures. As a minimum it was recommended that the results are presented with the uncertainties for key data.

3 Comparison of LCA Models for IWM systems

Joerg Winkler of the Technical University of Dresden, Germany described the results from the 4th round of comparisons of the LCA models for IWM systems. The conclusions were:

- there are no clear, systematic inconsistencies between the models;
- modelling approaches for greenhouse gases of landfills should be compared in detail;
- a common approach to fossil and biogenic carbon is needed;
- variation in results for incineration are generally lower than for landfill;
- different approaches to modelling heavy metals lead to different results;
- the significance of the energy grid is clear;
- use of the same electricity grid reduces the variation in the results of the offsets but due to differences in the amount of energy being offset in models, differences are still significant.

It was decided to continue the comparison of models further through an interactive workshop, concentrating on the reasons for key differences between the models. Further study areas were identified:

- the modelling of heavy metals and organic pollutants (dioxin, PCB, small amounts but large effect);
- processes in landfills (greenhouse gas production);
- scope of the LCI: which substances must be covered?

4 LCA and Integrated Waste Management Conference (Prague, April 13–16th, 2004)

David Pennington described a workshop and conference in Prague (April 13–14) that the DG JRC are co-ordinating. A draft agenda is available at http://viso.ei.jrc.it/iwmlca/index.html and abstracts should be sent to LCA-waste@jrc.it before 15th February 2004. The meeting is split: a 2 day workshop introducing the topics, providing case studies, and outlining available tools and 1.5 days split into 3 consecutive moderated poster/platform discussion sessions. The workshop will provide training and a chance to build collaborations to support EU Accession country delegates in LCA with a focus on waste management. The IEG agreed to support this initiative with active participation in the steering committee and promoting the support of its members to contribute to the training, as well as the poster/presentation sessions.

5 Landfill Time Dependency

The IEG agreed to develop an outline guidance document on the issue, describing the approaches used for the current models. Further research was identified on whether buffering and environment thresholds exist or not and if they do how to deal with bio-accumulative substances and plug releases (management control, aerobic releases, etc).

5.1 Landfill time dependency discounting issues – Best practice in LCA community

Göran Finnveden introduced the subject stating that one important starting point is that we need to consider several different types of wastes and landfills in order to find consistent methods and models. This is important when different types of waste treatment methods are compared, e.g. landfilling and incineration in which landfilling of both MSW and incineration residues must be handled. Landfills are open (at least partly), dynamic systems, whereas emissions from thermal treatment systems are immediate – therefore the question is how do landfill emissions change over time and how do we take this into account? An often used mental picture of landfill behaviour is one of exponential decline in Landfill emissions. But it is known that some wastes have buffering capacity, and when this is exhausted it can result in changes in leaching rates of heavy metals, redox and pH. Limited empirical work supports these relationships over time and different types of laboratory or mathematical models are necessary. Current LCA practise seems to fall in two groups. One group works with shorter time periods between 30–500 years. Other practitioners work with longer time periods, e.g. 60,000 years (based on expectations concerning the next glaciation) or infinite time periods. Some practitioners use both time perspectives, e.g. in Ecoinvent 2000, where two timeframes of 100 and 60,000 years are used). Since there are no scientific reasons to assume that emissions should stop after a certain time period, the choice of time period to consider is connected to ethical judgements and other valuations. For instance, it is possible to care less about emissions in future, assuming technological innovation in the future will be able to manage inherited sources of emissions or consider all emissions over an infinite timeframe as the classic definition of LCA requires. For LCIA, SETAC recommend infinite emissions consideration, or failing that, using 100 years with sensitivity analysis.

5.2 Landfill time dependency issues – A waste managers perspective

David Hall introduced the UK Environment Agency's 'Landsim' contaminant transport model, used to provide long-term modelling to 20,000 years from deposit. 'Gasim' was used to provide predictions for Landfill Gas (LFG). Both tools used a typical Euro Landfill Directive compliant scenario (small to medium-size) that was either dry tomb or flushing. Additionally, loss of institutional control was factored in at 60 years for some scenarios.

5.3 Emission factors for aerobic and anaerobic decomposition of biodegradable waste

Susan Thorneloe presented a paper on the US EPA landfill lifecycle inventory. The program undertook a series of laboratory simulations for biodegradation, supplemented by empirical field data. Simulations were conducted under Anaerobic and Aerobic conditions on shredded waste. For LFG and at composting sites the US EPA have used remote sensing to understand concentration gradients of emissions. See Life Cycle Inventory of a modern municipal solid waste landfill. Waste Management Research 17, 394–408 (1999).

6 Carbon and Energy

6.1 Carbon dioxide from waste treatment processes in LCA – A review of approaches

Simon Aumônier provided a summary of the IEG discussion to date. Forest carbon sequestration – there is conflicting opinion (between European research and the US EPA) over whether managed forest (sustainable forestry) provides an increased benefit at no net loss in quality. For an LCA practitioner, the option exists either to extend system boundaries or exclude biogenic sources of carbon. Waste management LCAs have tended towards the second approach. Landfill carbon sequestration – the IEG have agreed that carbon sequestration should be attributed to the process rather than waste management. Permanency of carbon sinks in relation to net carbon to atmosphere – slow and fast carbon cycles exist for waste management options, and for avoided energy. Biogenic and fossil carbon should be measured, sinks understood and all assumptions recorded. Simplified systems expansion approaches can be of some benefit. Essentially the IPCC (100 year) impact assessment presumes a time-dependent discount. Methodology need to be consistent so that fair comparisons can be made between incineration and landfill.

6.2 Consequences of waste incineration with energy recovery in three time perspectives

Tomas Ekvall presented research on the implications of wastepaper incineration in Swedish district heating systems. The research identifies the fuels that are offset through wastepaper incineration over three time perspectives. 1) Short term – fixed production capacity: wastepaper replaces other waste flows at the incinerators. 2) Long term – variable production capacity: wastepaper replaces mainly biofuel as baseload fuel in district-heat production. 3) Sustainable future – new technological context: materials, energy and food produced from arable land; recycling is probably more efficient than incineration. Continued research aims at identifying the consequences of biofuel being replaced by waste. Will biofuel production be affected, or will the biofuel be used elsewhere in the economy?